FIG. 1

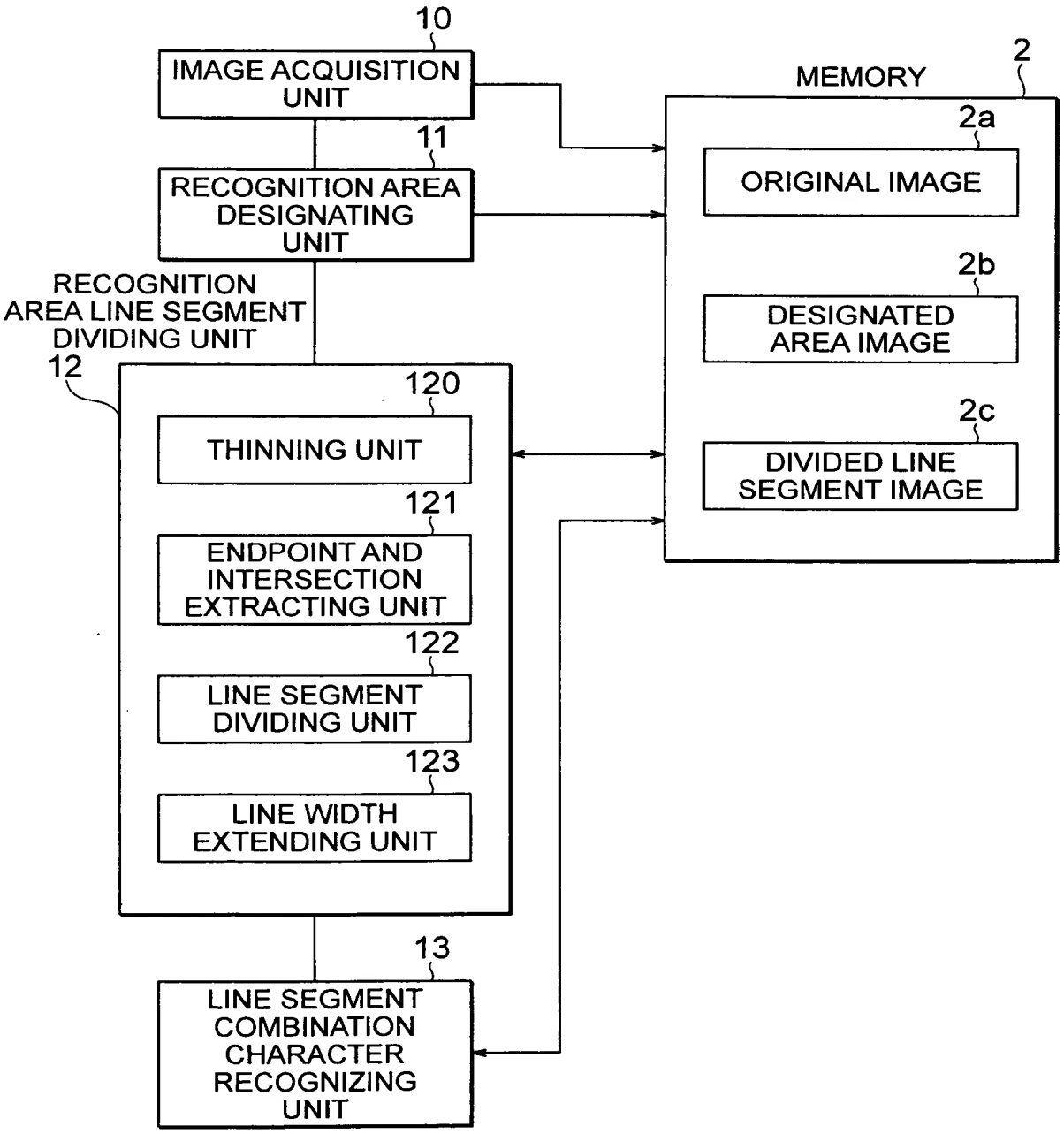
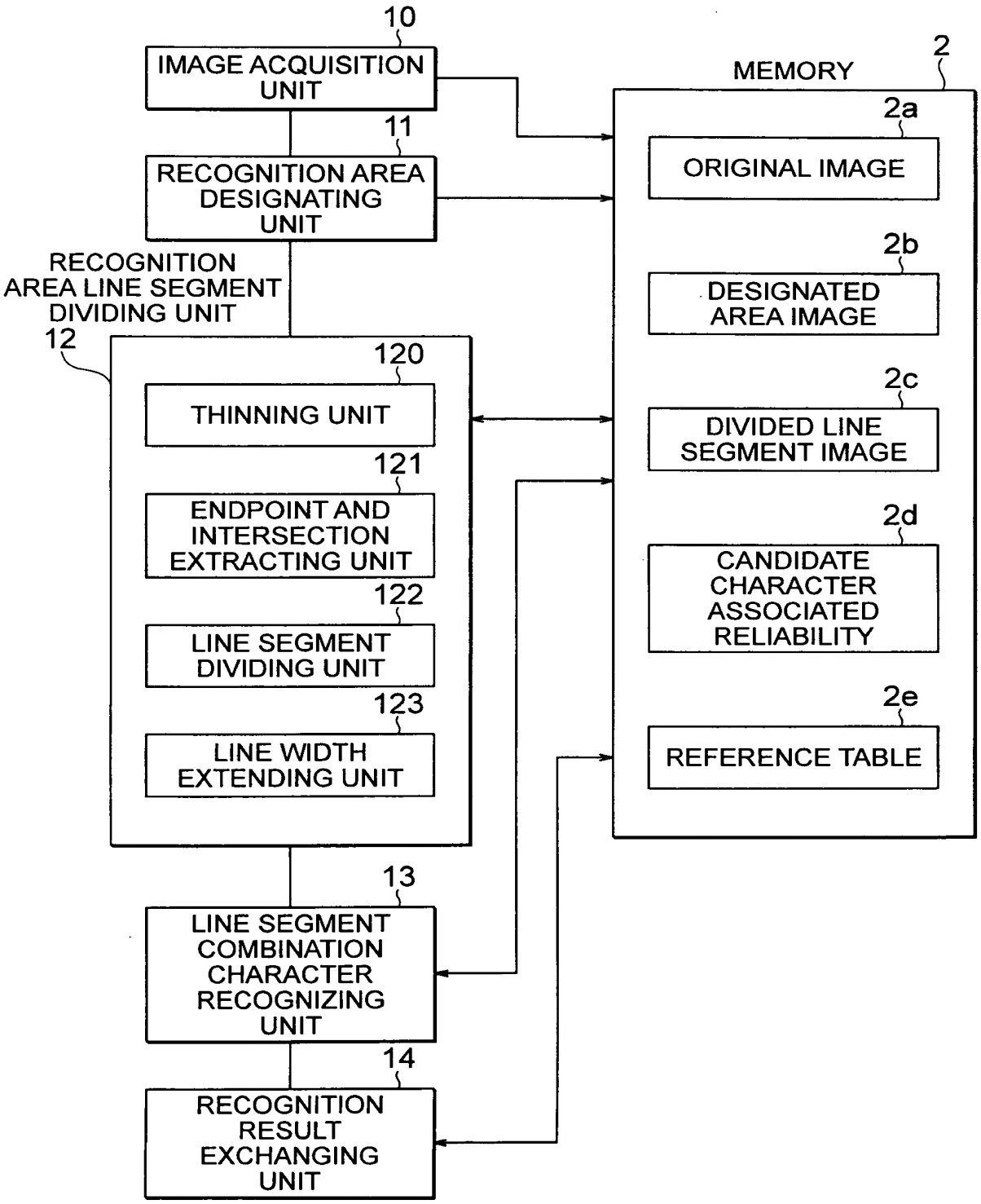

10
IMAGE ACQUISITION UNIT
11
RECOGNITION AREA DESIGNATING UNIT
RECOGNITION AREA LINE SEGMENT DIVIDING UNIT
12
120
THINNING UNIT
121
ENDPOINT AND INTERSECTION EXTRACTING UNIT
122
LINE SEGMENT DIVIDING UNIT
123
LINE WIDTH EXTENDING UNIT
13
LINE SEGMENT COMBINATION CHARACTER RECOGNIZING UNIT
MEMORY
2
2a
ORIGINAL IMAGE
2b
DESIGNATED AREA IMAGE
2c
DIVIDED LINE SEGMENT IMAGE

FIG. 2


10
IMAGE ACQUISITION UNIT
11
RECOGNITION AREA DESIGNATING UNIT
RECOGNITION AREA LINE SEGMENT DIVIDING UNIT
12
120
THINNING UNIT
121
ENDPOINT AND INTERSECTION EXTRACTING UNIT
122
LINE SEGMENT DIVIDING UNIT
123
LINE WIDTH EXTENDING UNIT
13
LINE SEGMENT COMBINATION CHARACTER RECOGNIZING UNIT
14
RECOGNITION RESULT EXCHANGING UNIT
MEMORY
2
2a
ORIGINAL IMAGE
2b
DESIGNATED AREA IMAGE
2c
DIVIDED LINE SEGMENT IMAGE
2d
CANDIDATE CHARACTER ASSOCIATED RELIABILITY
2e
REFERENCE TABLE

EP 0 878 761 A2

FIG. 3

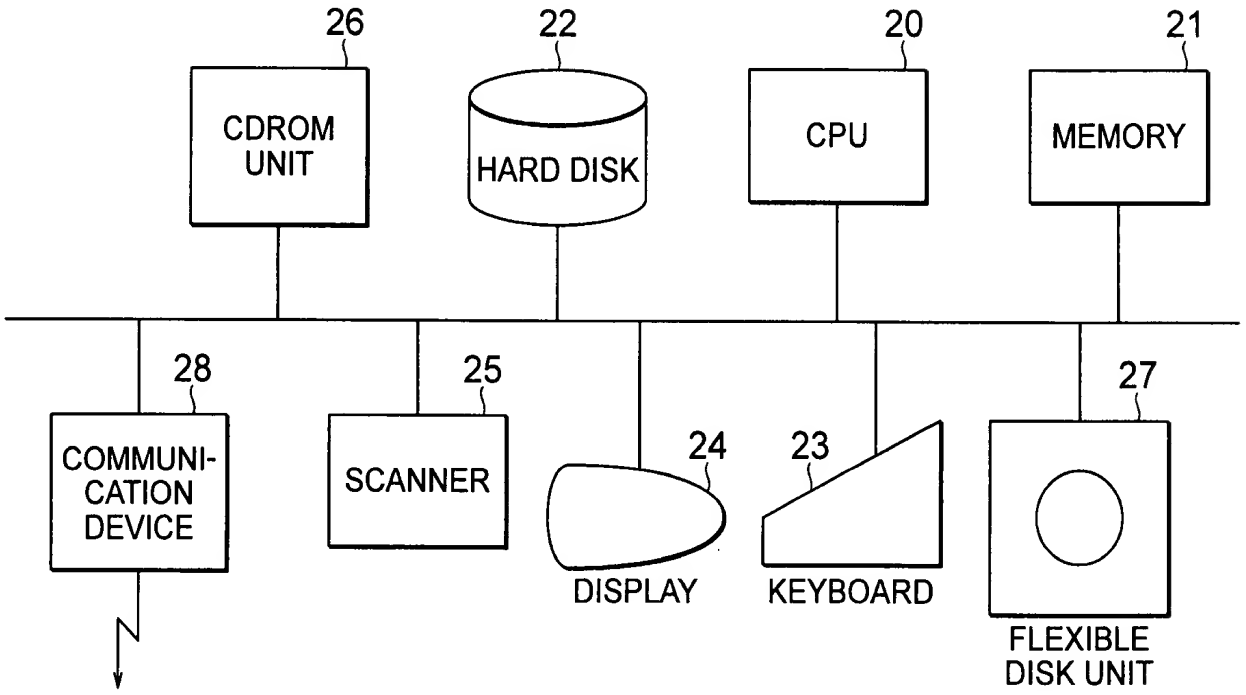


FIG. 4

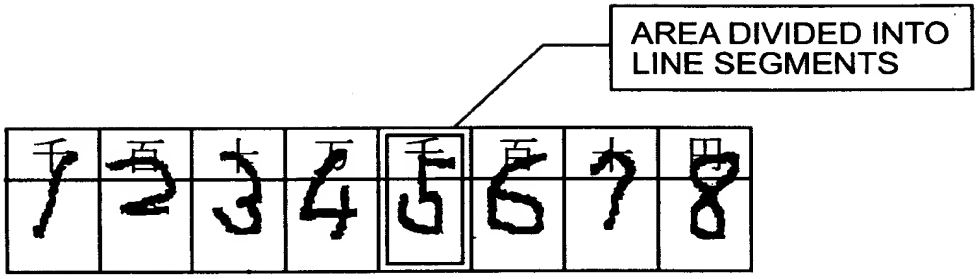


FIG. 5

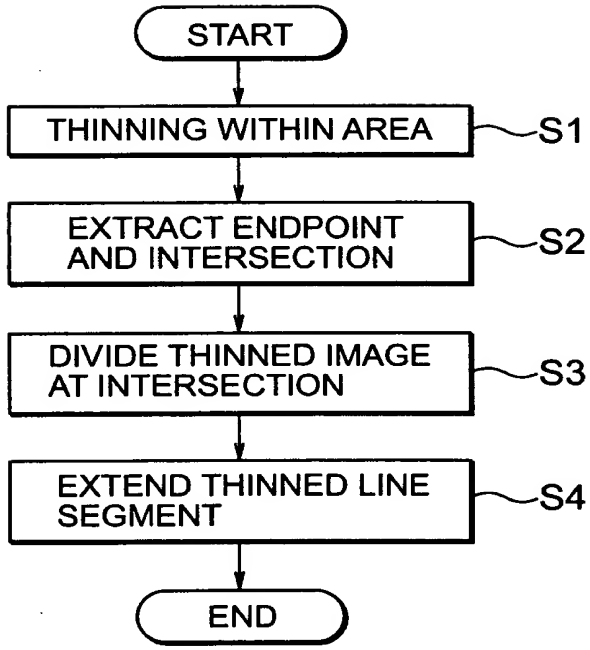

START
THINNING WITHIN AREA
S1
EXTRACT ENDPOINT AND INTERSECTION
S2
DIVIDE THINNED IMAGE AT INTERSECTION
S3
EXTEND THINNED LINE SEGMENT
S4
END

FIG. 6

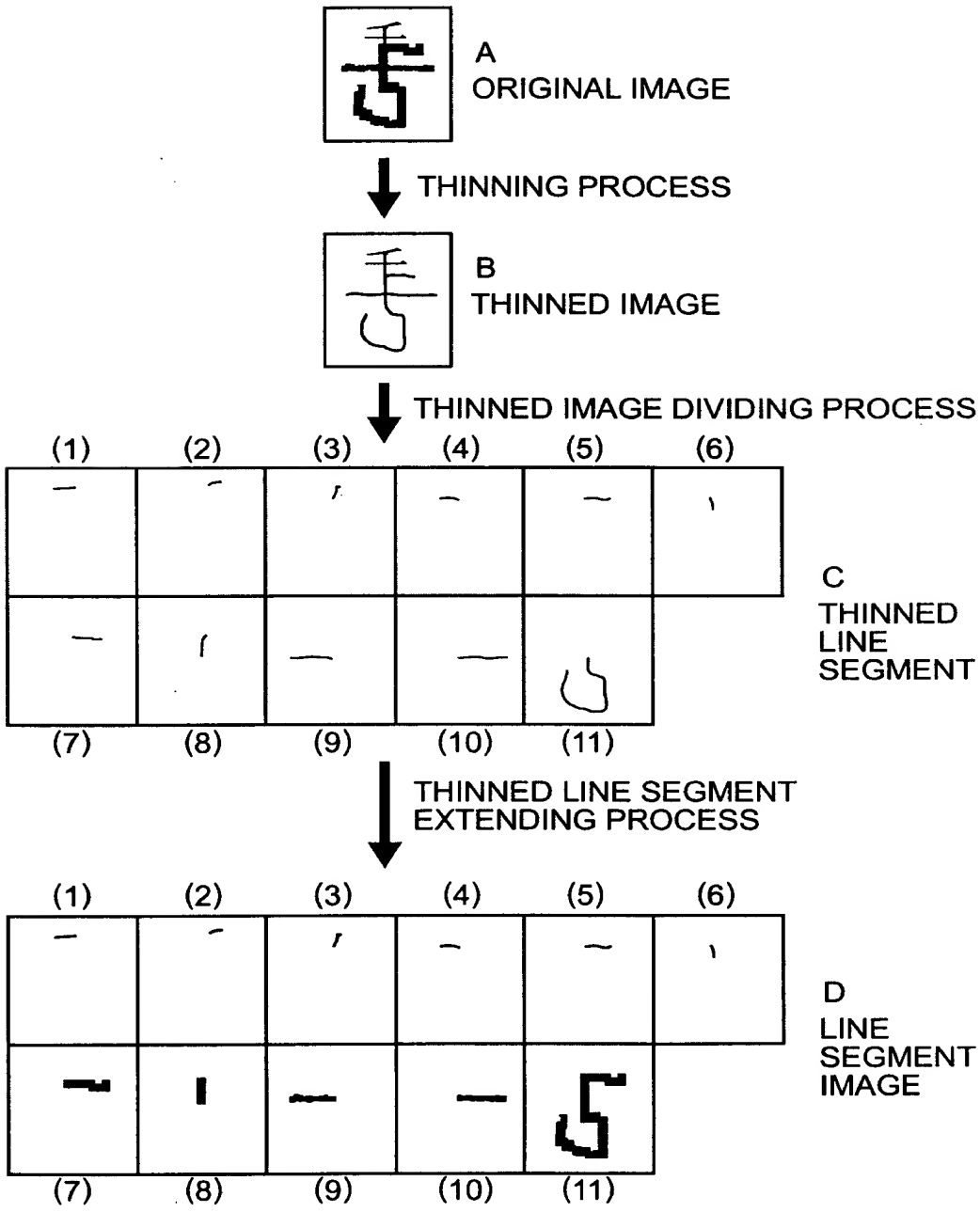

A
ORIGINAL IMAGE
THINNING PROCESS
B
THINNED IMAGE
THINNED IMAGE DIVIDING PROCESS
(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)
(10)
(11)
C
THINNED
LINE
SEGMENT
THINNED LINE SEGMENT
EXTENDING PROCESS
D
LINE
SEGMENT
IMAGE

FIG. 7

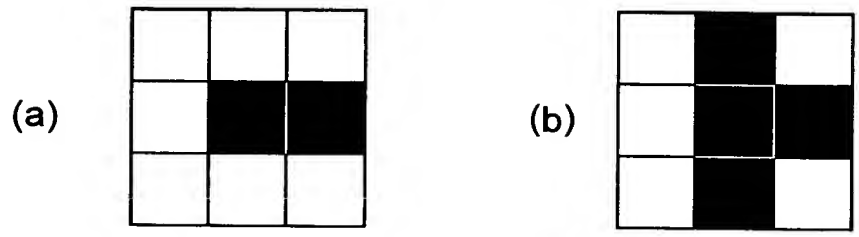


FIG. 8

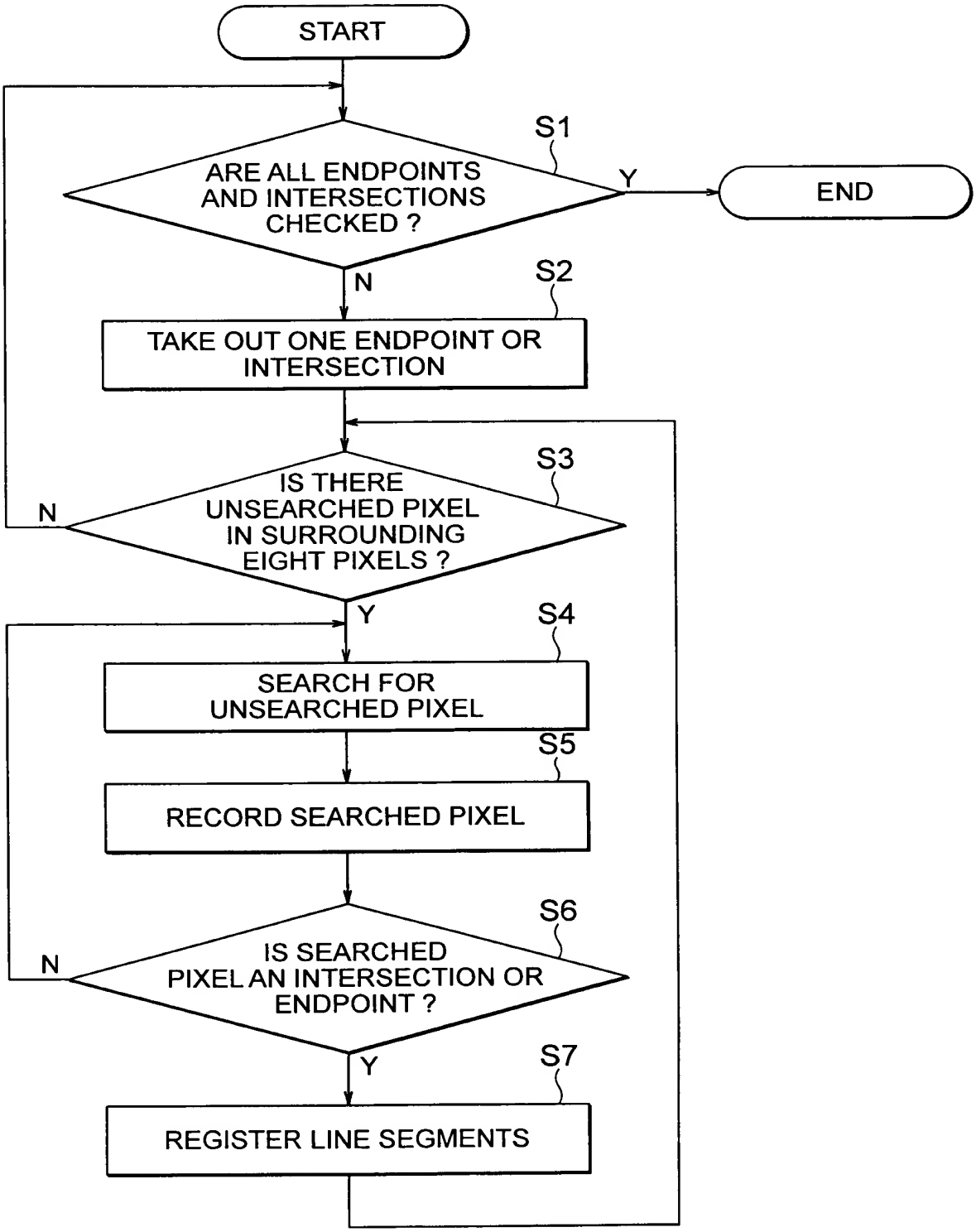

START
S1
ARE ALL ENDPOINTS AND INTERSECTIONS CHECKED ?
Y
END
N
S2
TAKE OUT ONE ENDPOINT OR INTERSECTION
S3
IS THERE UNSEARCHED PIXEL IN SURROUNDING EIGHT PIXELS ?
N
Y
S4
SEARCH FOR UNSEARCHED PIXEL
S5
RECORD SEARCHED PIXEL
S6
IS SEARCHED PIXEL AN INTERSECTION OR ENDPOINT ?
N
Y
S7
REGISTER LINE SEGMENTS

FIG. 9

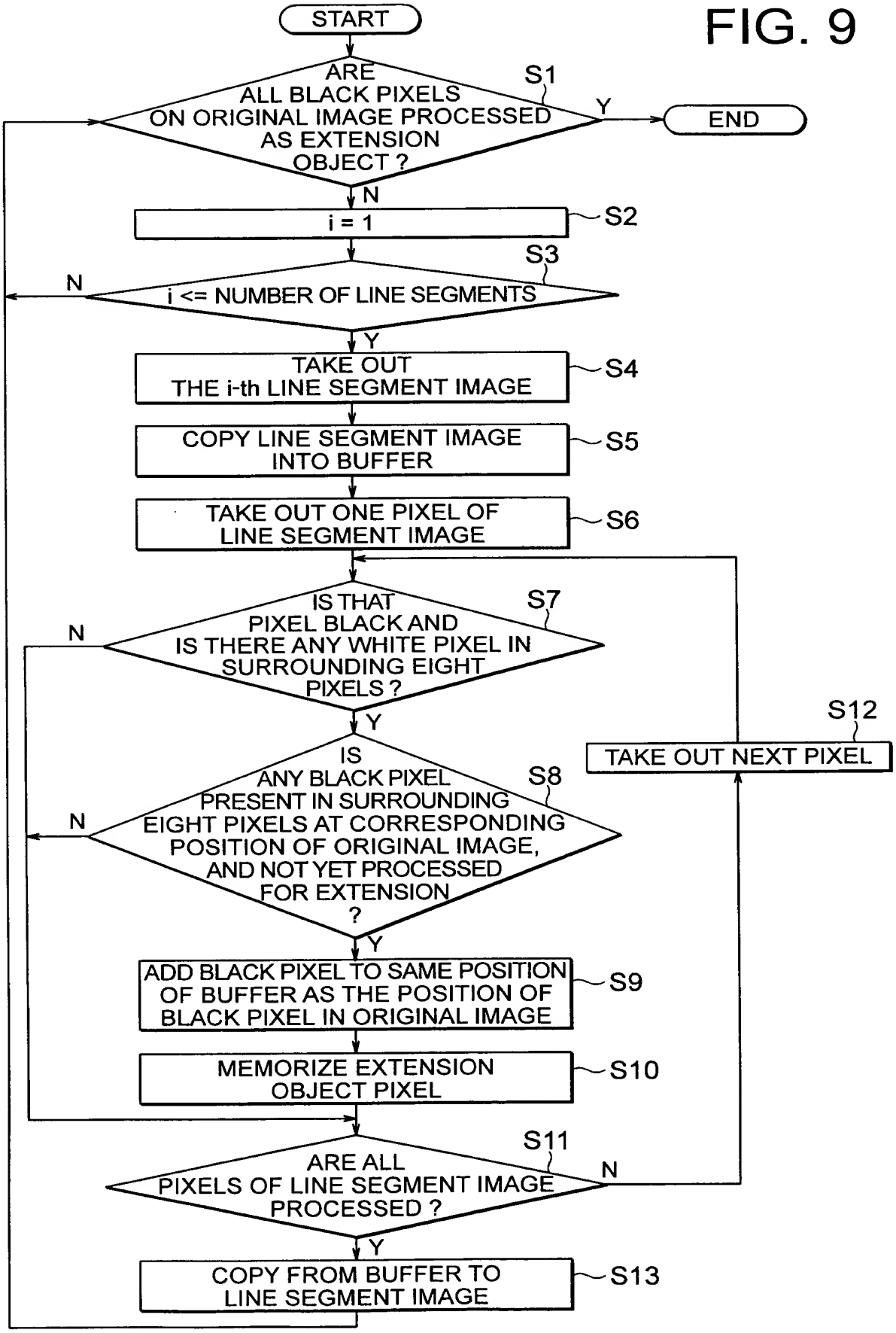

START
ARE ALL BLACK PIXELS ON ORIGINAL IMAGE PROCESSED AS EXTENSION OBJECT ?
S1
Y
END
N
i = 1
S2
S3
N
i <= NUMBER OF LINE SEGMENTS
Y
TAKE OUT THE i-th LINE SEGMENT IMAGE
S4
COPY LINE SEGMENT IMAGE INTO BUFFER
S5
TAKE OUT ONE PIXEL OF LINE SEGMENT IMAGE
S6
IS THAT PIXEL BLACK AND IS THERE ANY WHITE PIXEL IN SURROUNDING EIGHT PIXELS ?
S7
N
Y
IS ANY BLACK PIXEL PRESENT IN SURROUNDING EIGHT PIXELS AT CORRESPONDING POSITION OF ORIGINAL IMAGE, AND NOT YET PROCESSED FOR EXTENSION ?
S8
N
Y
ADD BLACK PIXEL TO SAME POSITION OF BUFFER AS THE POSITION OF BLACK PIXEL IN ORIGINAL IMAGE
S9
MEMORIZE EXTENSION OBJECT PIXEL
S10
S12
TAKE OUT NEXT PIXEL
ARE ALL PIXELS OF LINE SEGMENT IMAGE PROCESSED ?
S11
N
Y
COPY FROM BUFFER TO LINE SEGMENT IMAGE
S13

FIG. 10

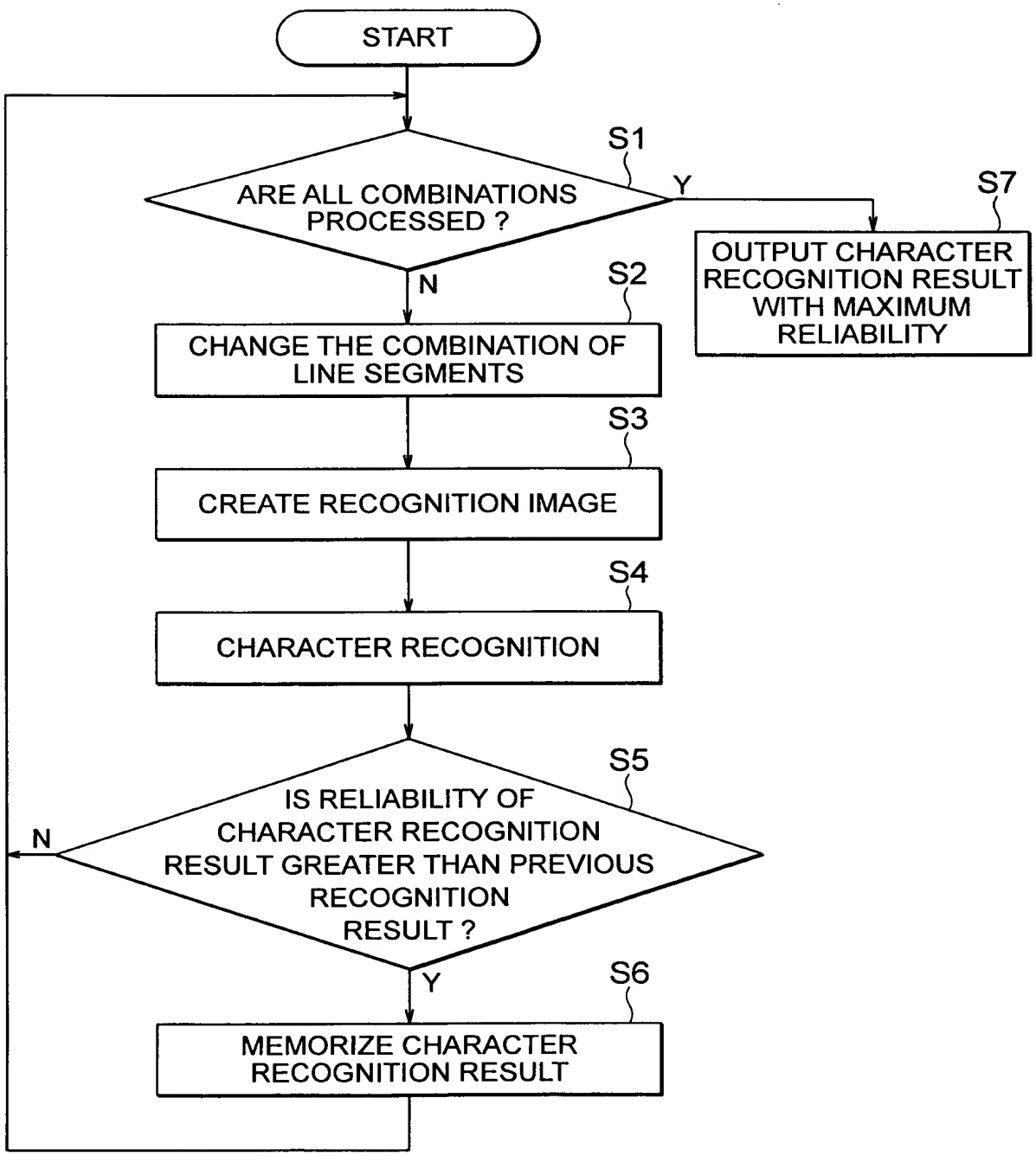

START
S1
ARE ALL COMBINATIONS PROCESSED ?
Y
S7
OUTPUT CHARACTER RECOGNITION RESULT WITH MAXIMUM RELIABILITY
N
S2
CHANGE THE COMBINATION OF LINE SEGMENTS
S3
CREATE RECOGNITION IMAGE
S4
CHARACTER RECOGNITION
S5
IS RELIABILITY OF CHARACTER RECOGNITION RESULT GREATER THAN PREVIOUS RECOGNITION RESULT ?
N
Y
S6
MEMORIZE CHARACTER RECOGNITION RESULT

FIG. 11

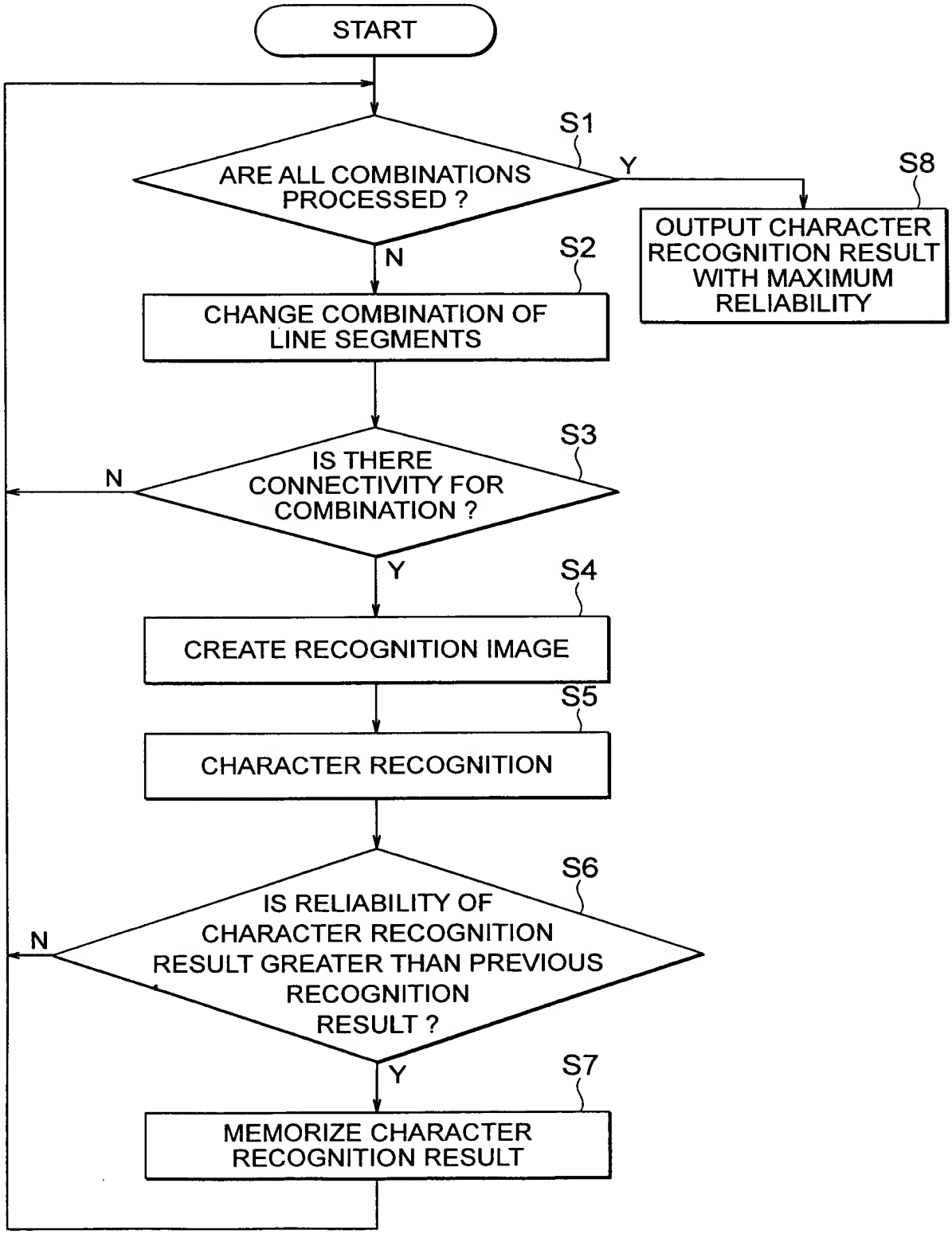

START
S1
ARE ALL COMBINATIONS PROCESSED ?
Y
S8
OUTPUT CHARACTER RECOGNITION RESULT WITH MAXIMUM RELIABILITY
N
S2
CHANGE COMBINATION OF LINE SEGMENTS
S3
IS THERE CONNECTIVITY FOR COMBINATION ?
N
Y
S4
CREATE RECOGNITION IMAGE
S5
CHARACTER RECOGNITION
S6
IS RELIABILITY OF CHARACTER RECOGNITION RESULT GREATER THAN PREVIOUS RECOGNITION RESULT ?
N
Y
S7
MEMORIZE CHARACTER RECOGNITION RESULT

FIG. 12

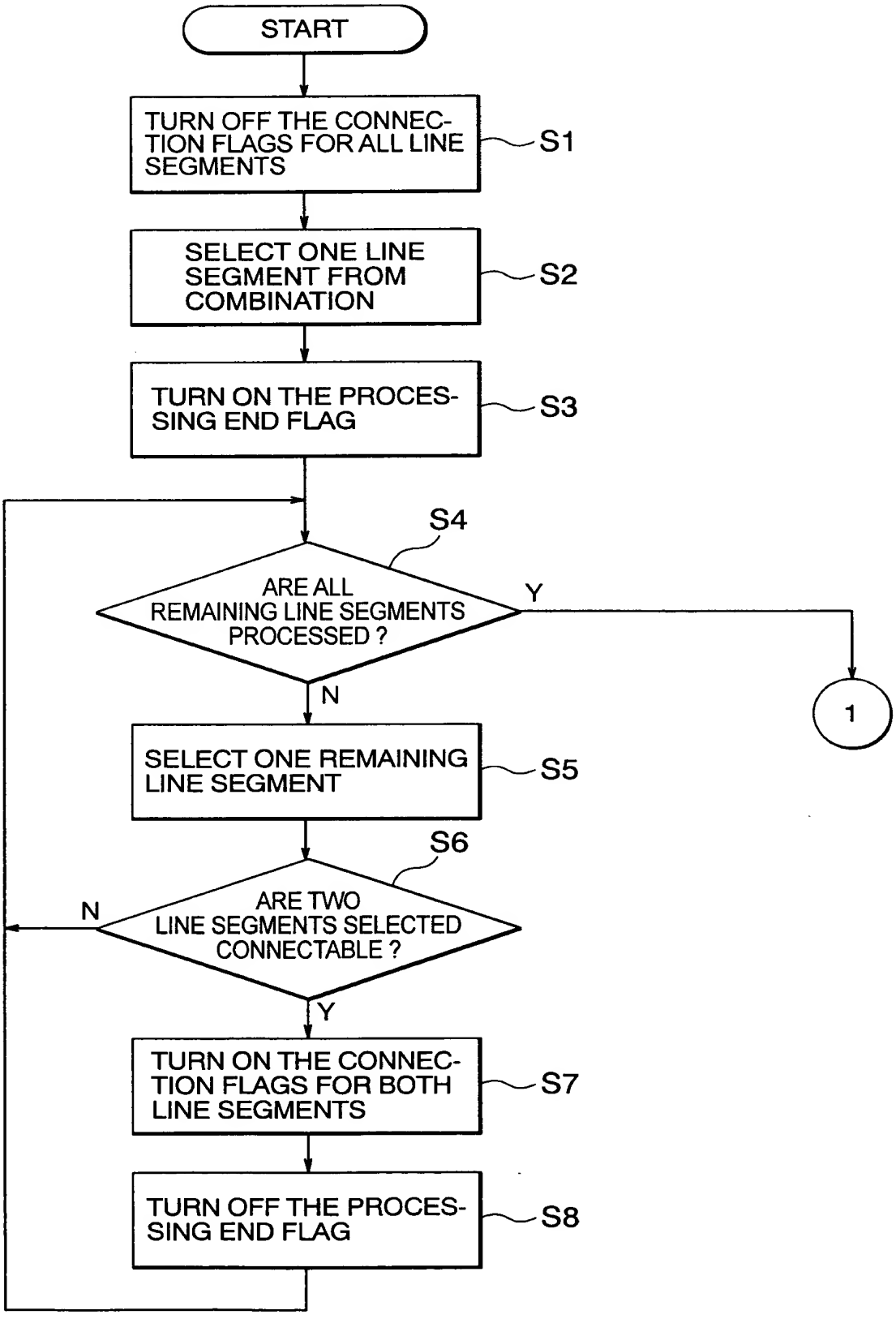
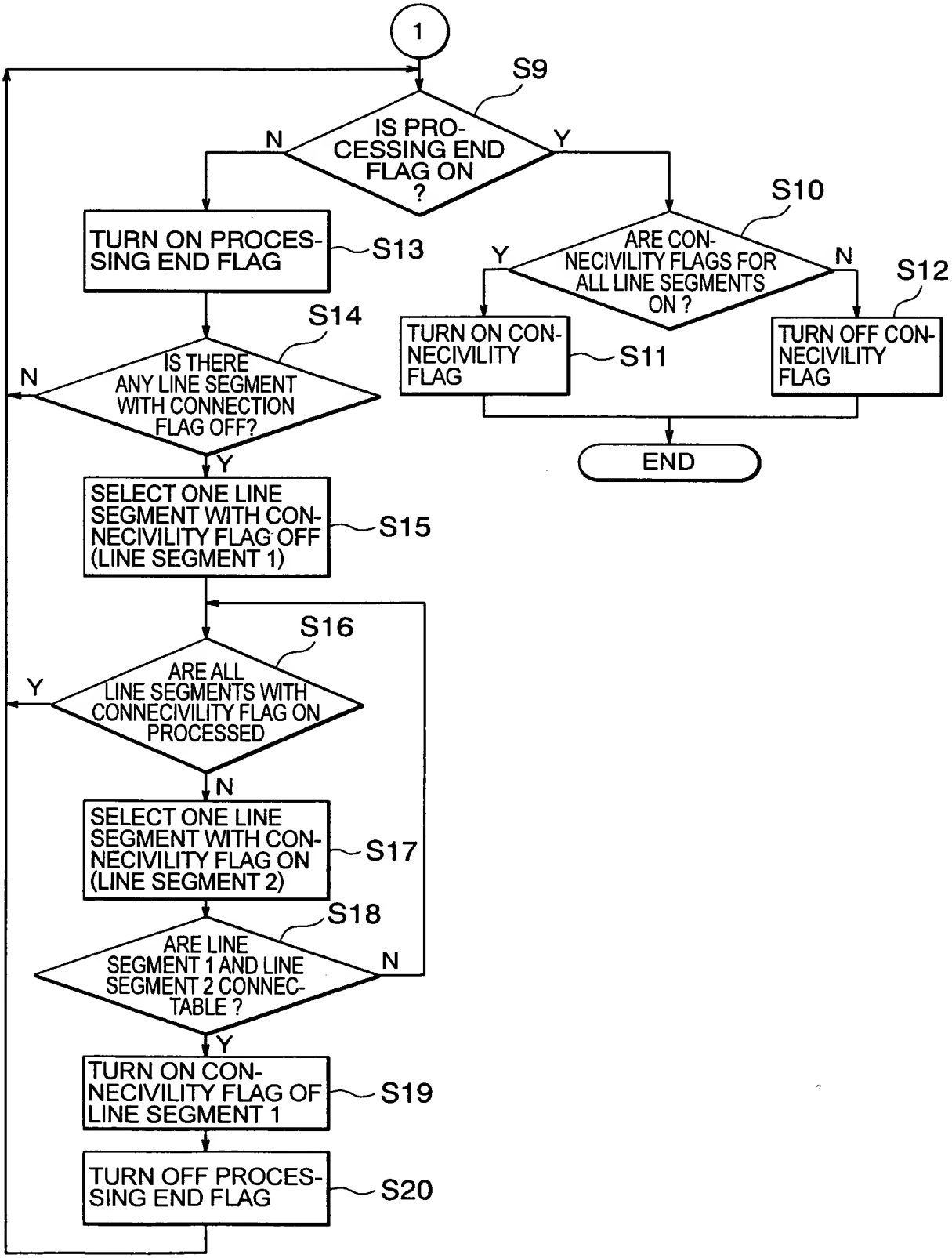

START
TURN OFF THE CONNECTION FLAGS FOR ALL LINE SEGMENTS
S1
SELECT ONE LINE SEGMENT FROM COMBINATION
S2
TURN ON THE PROCESSING END FLAG
S3
S4
ARE ALL REMAINING LINE SEGMENTS PROCESSED ?
Y
N
1
SELECT ONE REMAINING LINE SEGMENT
S5
S6
ARE TWO LINE SEGMENTS SELECTED CONNECTABLE ?
N
Y
TURN ON THE CONNECTION FLAGS FOR BOTH LINE SEGMENTS
S7
TURN OFF THE PROCESSING END FLAG
S8

FIG. 13


1
S9
IS PRO-CESSING END FLAG ON ?
N
Y
TURN ON PROCES-SING END FLAG
S13
S10
ARE CON-NECIVILITY FLAGS FOR ALL LINE SEGMENTS ON ?
Y
N
S12
TURN ON CON-NECIVILITY FLAG
S11
TURN OFF CON-NECIVILITY FLAG
END
S14
IS THERE ANY LINE SEGMENT WITH CONNECTION FLAG OFF?
N
Y
SELECT ONE LINE SEGMENT WITH CON-NECIVILITY FLAG OFF (LINE SEGMENT 1)
S15
S16
ARE ALL LINE SEGMENTS WITH CONNECIVILITY FLAG ON PROCESSED
Y
N
SELECT ONE LINE SEGMENT WITH CON-NECIVILITY FLAG ON (LINE SEGMENT 2)
S17
S18
ARE LINE SEGMENT 1 AND LINE SEGMENT 2 CONNEC-TABLE ?
N
Y
TURN ON CON-NECIVILITY FLAG OF LINE SEGMENT 1
S19
TURN OFF PROCES-SING END FLAG
S20

JP 2001-160150 A 2001.6.12

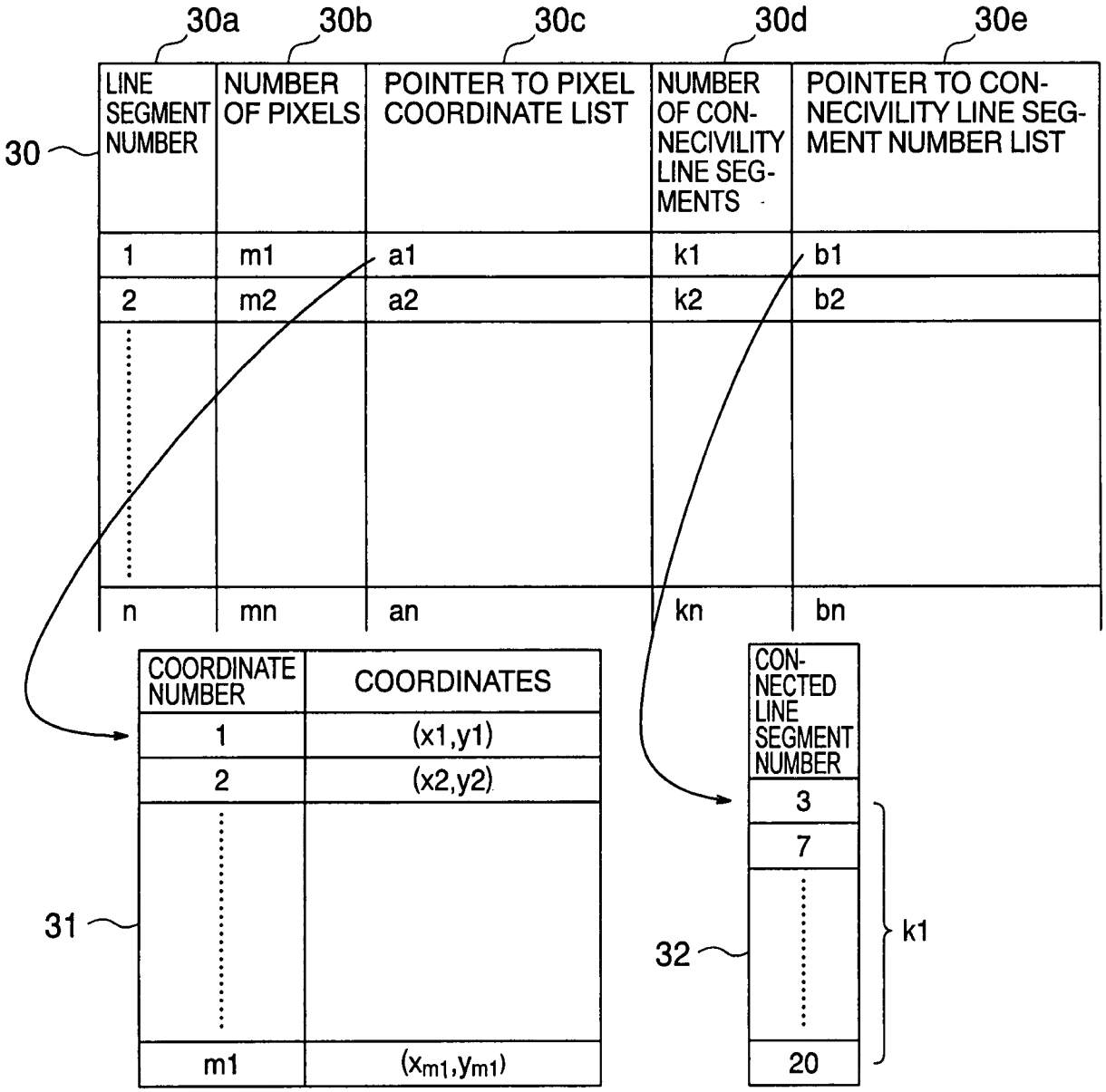
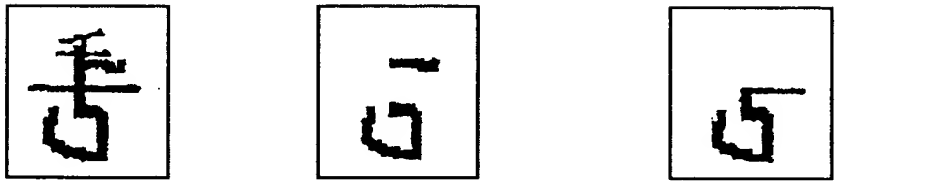


FIG. 14

FIG. 15

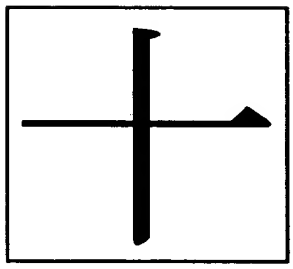


(a) ORIGINAL IMAGE

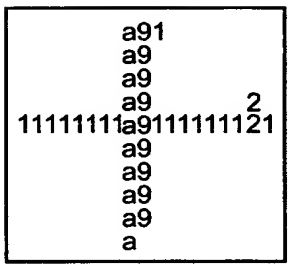
(b) COMBINATION WITHOUT CONNECTIVITY

(c) COMBINATION WITH CONNECTIVITY

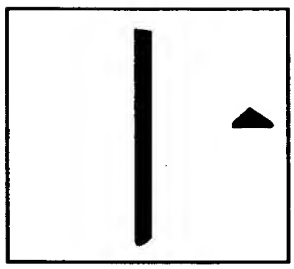
FIG. 16



(a) IMAGE "+" IN MING-STYLE TYPE

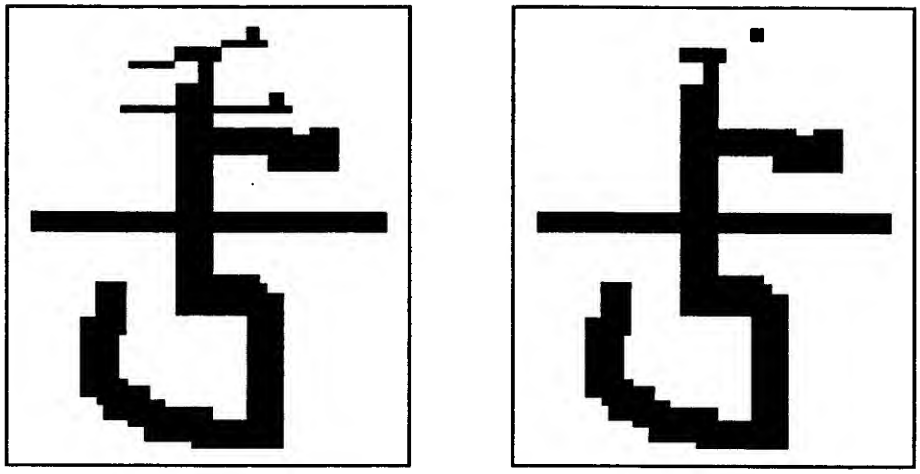


(b) RUN DISTRIBUTION OF IMAGE "+" IN MING-STYLE TYPE IN VERTICAL DIRECTION



(a) IMAGE "+" IN MING-STYLE TYPE FROM WHICH PORTION WITH RUN WIDTH 1 IN VERTICAL DIRECTION IS DELETED

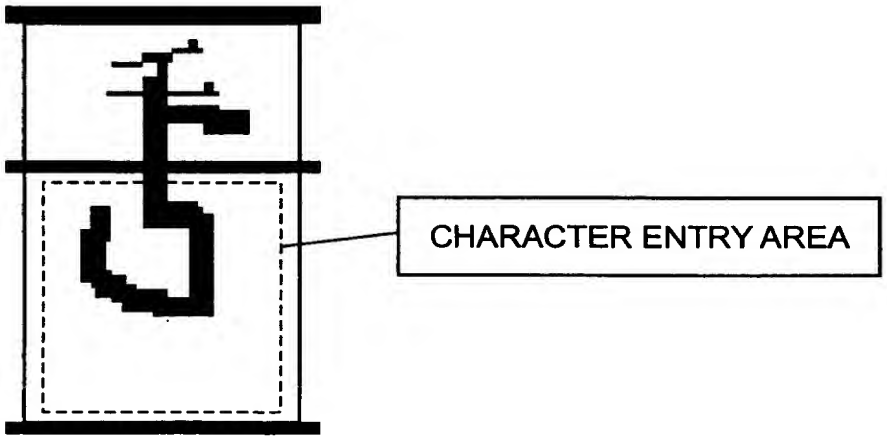
FIG. 17



(a) ORIGNAL IMAGE

(b) IMAGE AFTER ITS PORTION WITH FINE LINE WIDTH IS REMOVED

FIG. 18



EP 0 881 601 A2

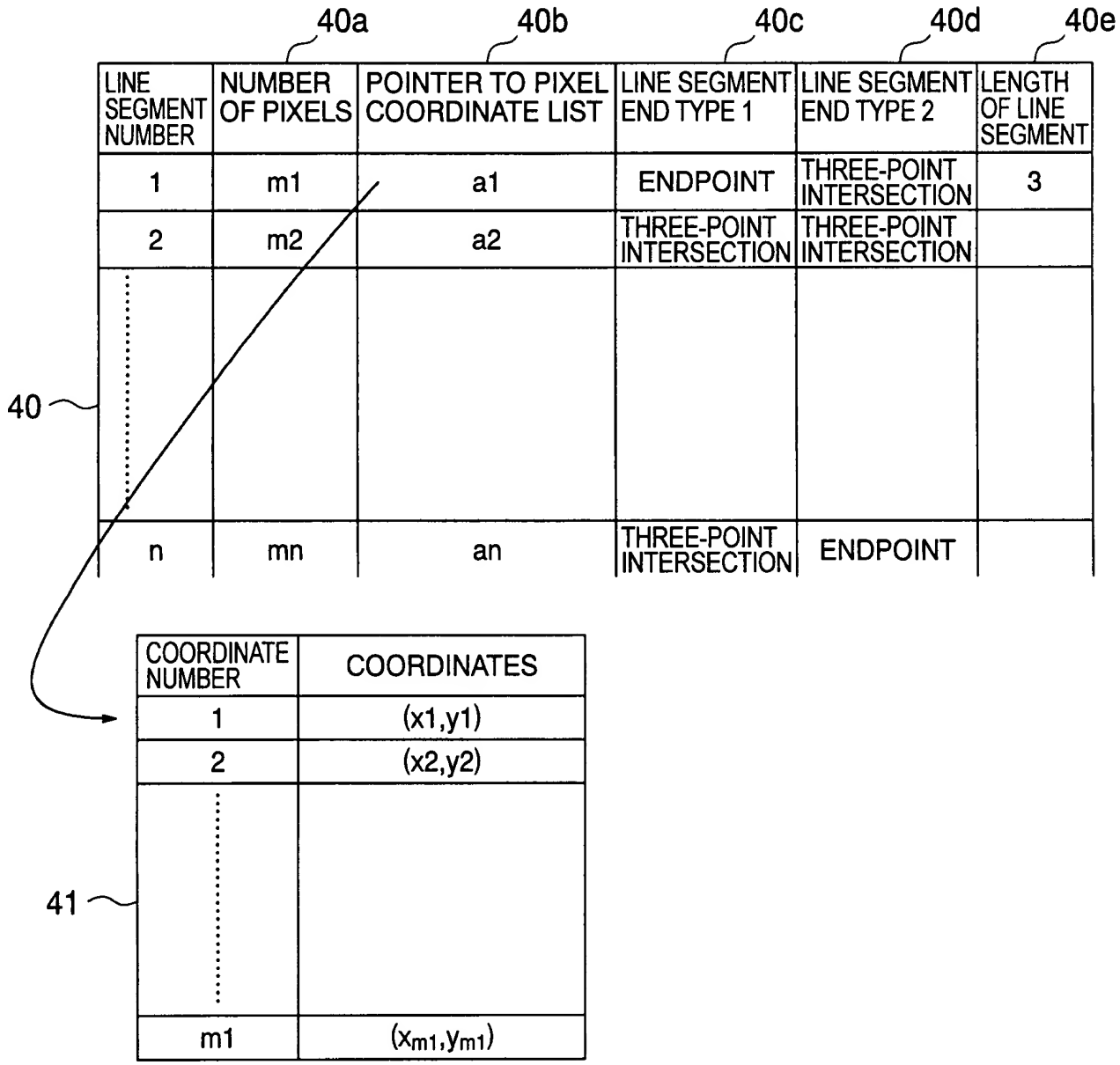
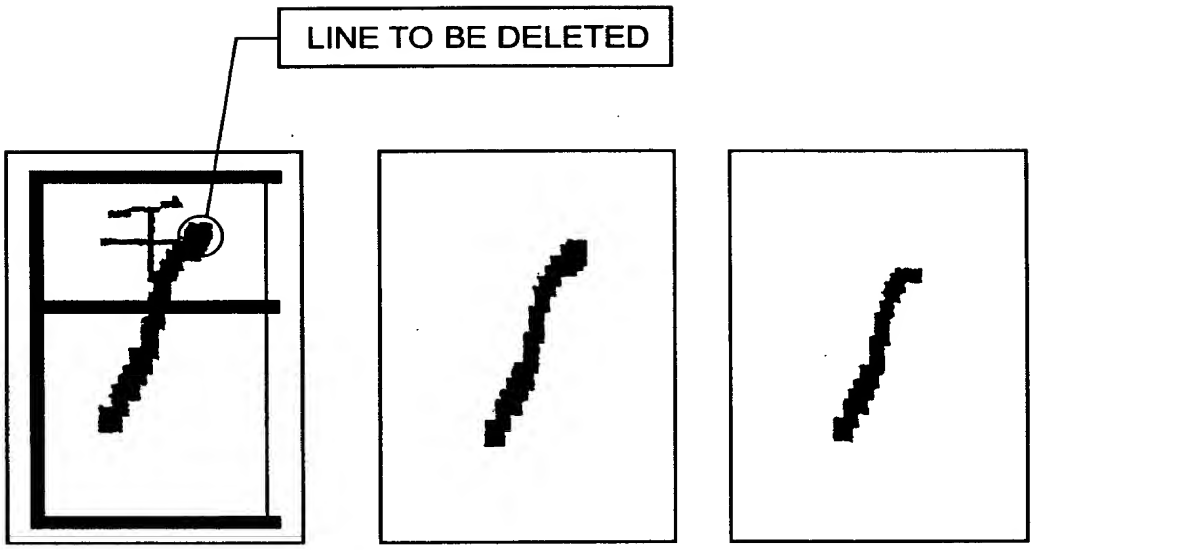


FIG. 19

FIG. 20



A ORIGNAL IMAGE

B ENTRY CHARACTER

C WHEN SHORT LINE SEGMENT CONNECTING TO ENDPOINT IS DELETED

FIG. 21

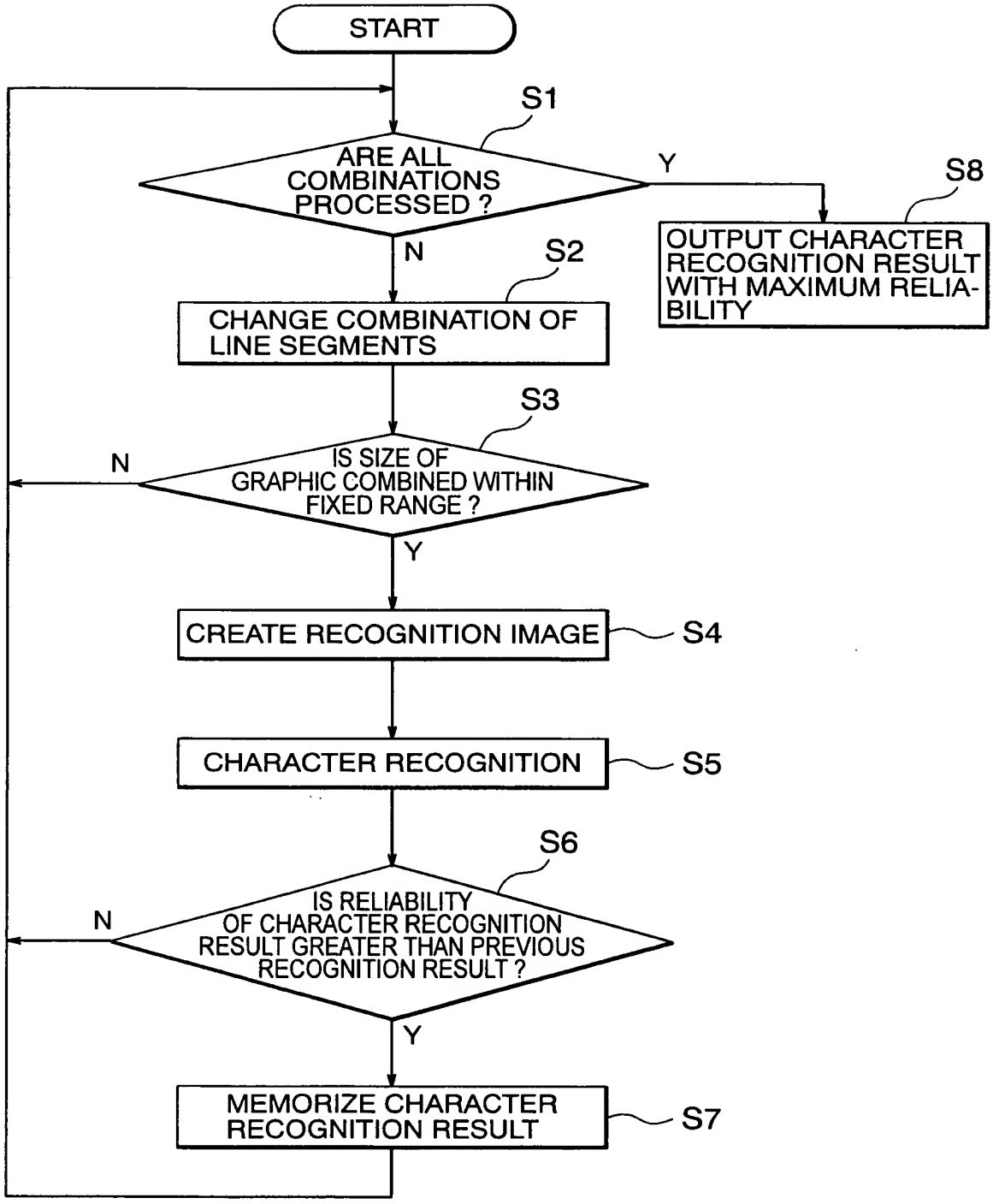

START
S1
ARE ALL COMBINATIONS PROCESSED ?
Y
S8
OUTPUT CHARACTER RECOGNITION RESULT WITH MAXIMUM RELIABILITY
N
S2
CHANGE COMBINATION OF LINE SEGMENTS
S3
N
IS SIZE OF GRAPHIC COMBINED WITHIN FIXED RANGE ?
Y
CREATE RECOGNITION IMAGE
S4
CHARACTER RECOGNITION
S5
S6
N
IS RELIABILITY OF CHARACTER RECOGNITION RESULT GREATER THAN PREVIOUS RECOGNITION RESULT ?
Y
MEMORIZE CHARACTER RECOGNITION RESULT
S7

FIG. 22

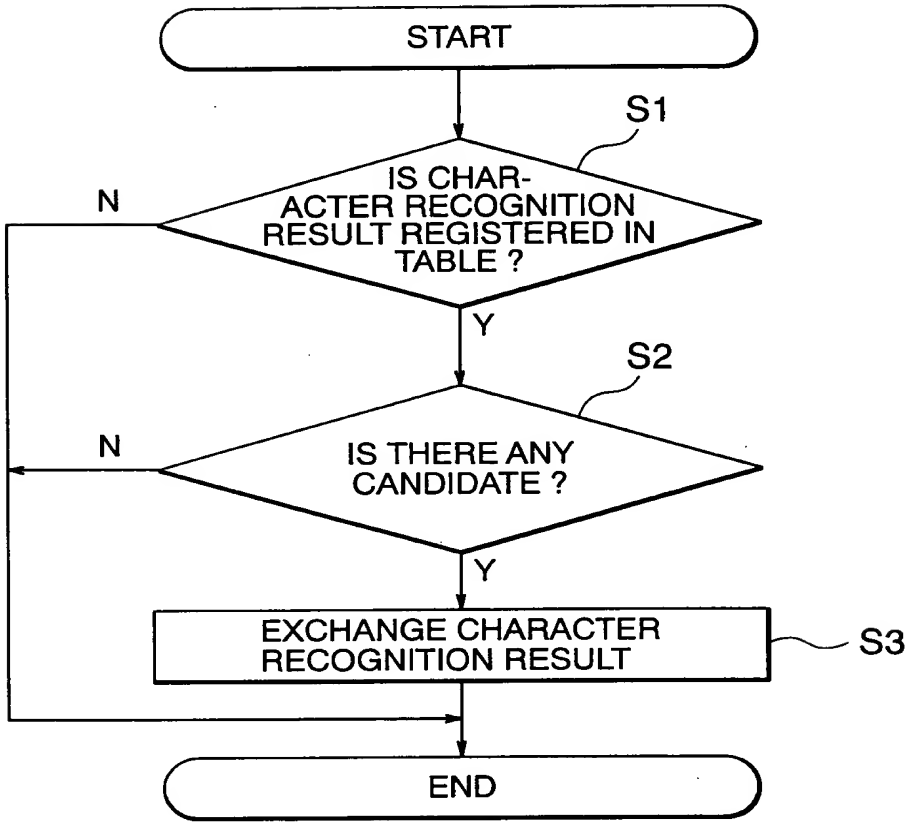


FIG. 23

EXCHANGED OBJECT CHARACTER	EXCHANGING OBJECT CHARACTER
0	6 , 8
1	4 , 7 , 9
6	0
8	0

FIG. 24

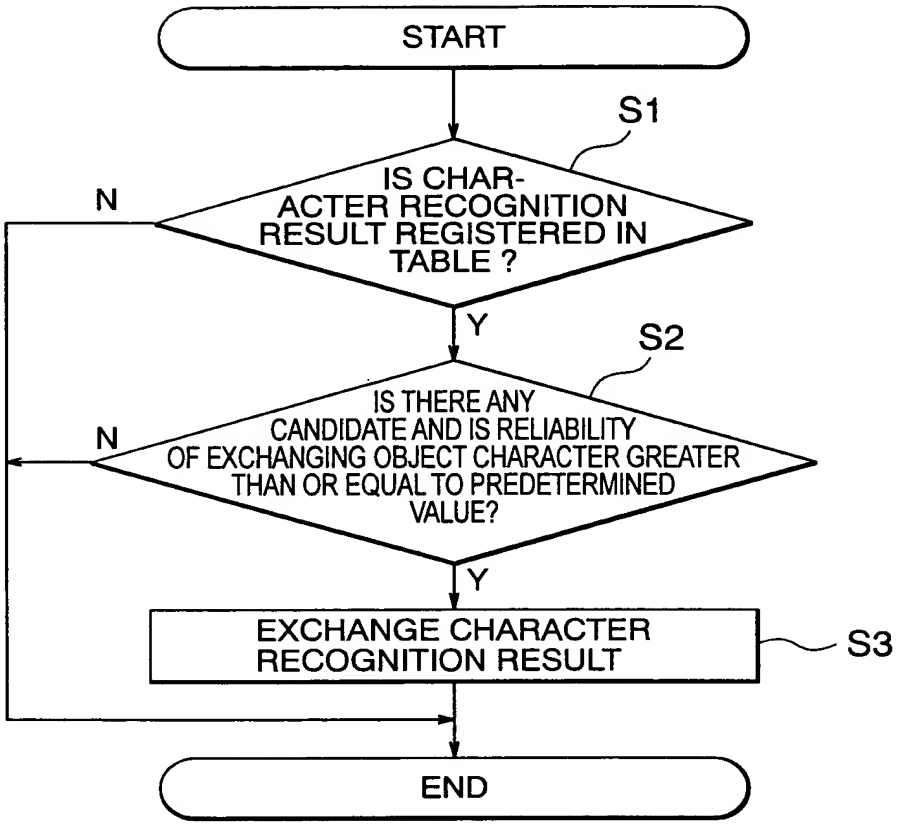


FIG. 25

EXCHANGED OBJECT CHARACTER	EXCHANGING OBJECT CHARACTER	RELIABILITY WHEN EXCHANGING
0	6	200
	8	220
1	4	230
	7	200
	9	240
6	0	220
8	0	250

FIG. 26

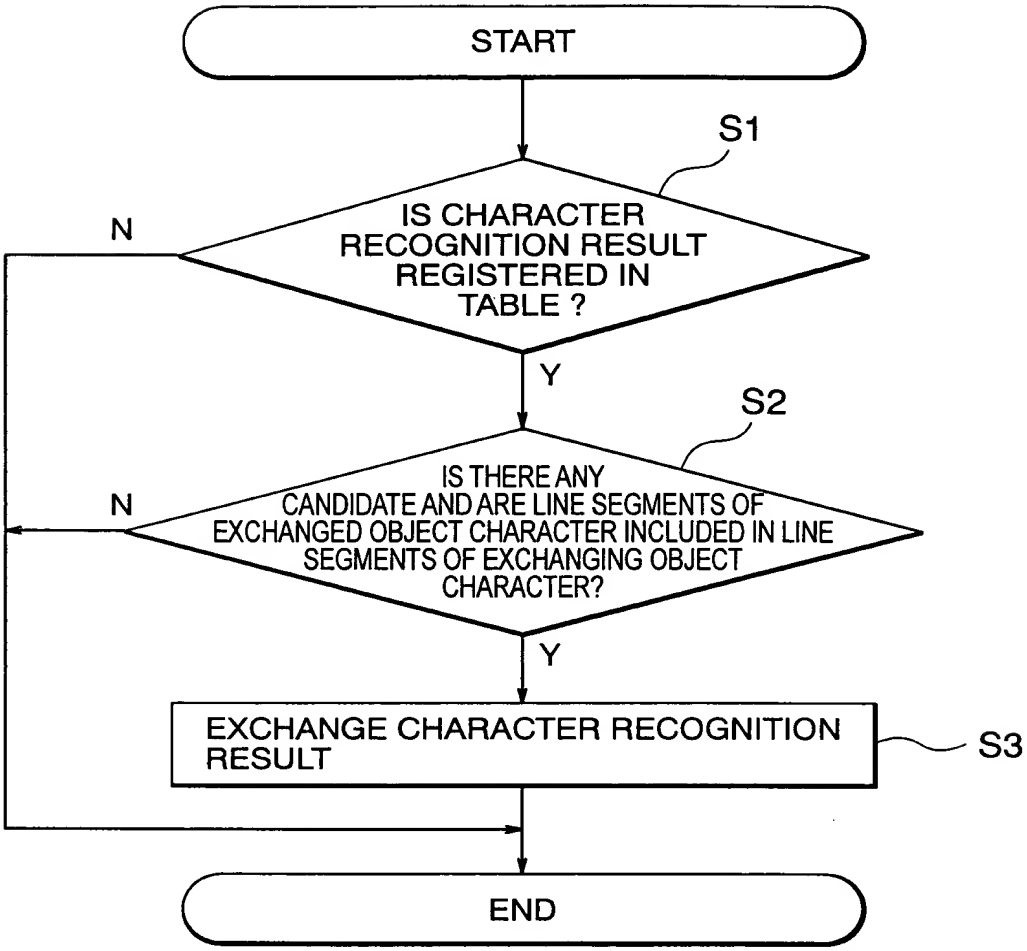

START
S1
IS CHARACTER RECOGNITION RESULT REGISTERED IN TABLE ?
N
Y
S2
IS THERE ANY CANDIDATE AND ARE LINE SEGMENTS OF EXCHANGED OBJECT CHARACTER INCLUDED IN LINE SEGMENTS OF EXCHANGING OBJECT CHARACTER?
N
Y
EXCHANGE CHARACTER RECOGNITION RESULT
S3
END

FIG. 27

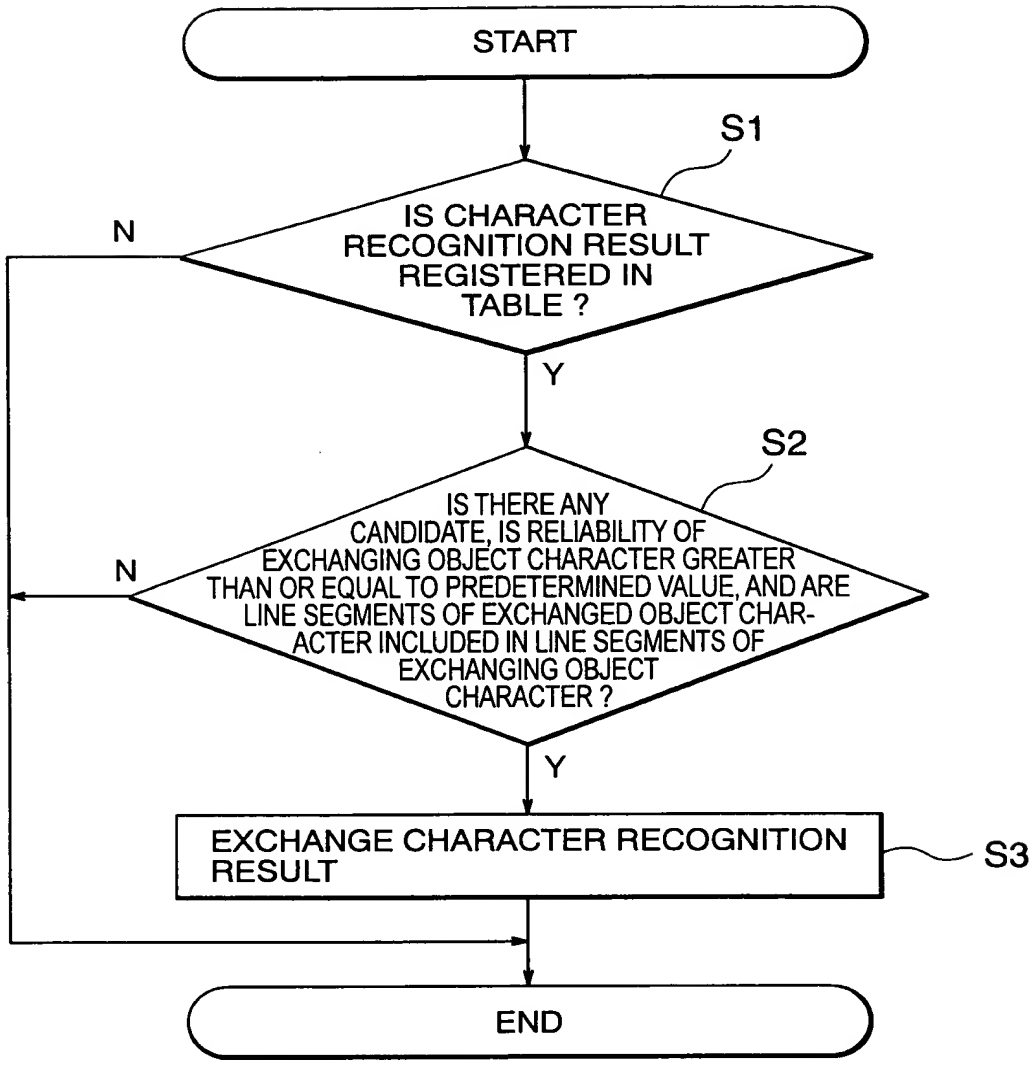

START
S1
IS CHARACTER RECOGNITION RESULT REGISTERED IN TABLE ?
N
Y
S2
IS THERE ANY CANDIDATE, IS RELIABILITY OF EXCHANGING OBJECT CHARACTER GREATER THAN OR EQUAL TO PREDETERMINED VALUE, AND ARE LINE SEGMENTS OF EXCHANGED OBJECT CHARACTER INCLUDED IN LINE SEGMENTS OF EXCHANGING OBJECT CHARACTER ?
N
Y
EXCHANGE CHARACTER RECOGNITION RESULT
S3
END

FIG. 28

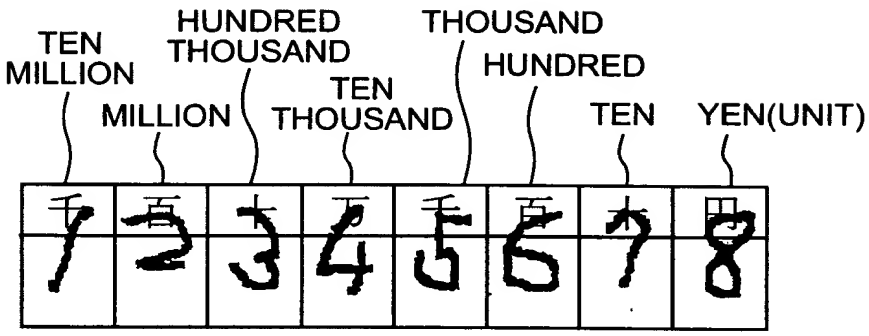

TEN MILLION
MILLION
HUNDRED THOUSAND
TEN THOUSAND
THOUSAND
HUNDRED
TEN
YEN(UNIT)
千
百
十
万
千
百
十
円
1
2
3
4
5
6
7
8

FIG. 29

INSTANCE OF FALSE RECOGNITION

INPUT IMAGE
(ENTRY CHARACTER "7")

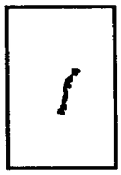


IMAGE EMPLOYED AS
RECOGNITION RESULT
(RECOGNITION RESULT "1")

(a)

INPUT IMAGE
(ENTRY CHARACTER "8")

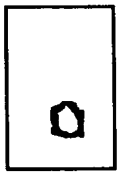
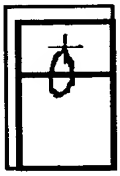


IMAGE EMPLOYED AS
RECOGNITION RESULT
(RECOGNITION RESULT "0")

(b)



INPUT IMAGE
(ENTRY CHARACTER "0")

IMAGE EMPLOYED AS
RECOGNITION RESULT
(RECOGNITION RESULT "6")

(c)